

DOCUMENT-IDENTIFIER: US 5648284 A
TITLE: Field effect transistor including silicon
oxide film and nitrided oxide
film as gate insulator film and manufacturing
method thereof

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A description will now be made on the fact that a trap density of a nitrided oxide film is lower than that of a silicon oxide film. It is known that the trap density of a silicon nitride film is 100 to 1000 times higher than that of the silicon oxide film. This is disclosed in, for example, "THE Si--SiO₂ SYSTEM" by Pieter Balk, p. 32, MATERIALS SCIENCE MONOGRAPHS, publ. by Elsevier.

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As can be seen from the graph, the total V_{sub.G} shift of an RNO gate is ten times lower than that of an OX gate. Since the trap density is in proportion to the total V_{sub.G} shift, it is considered that the trap density of RNO is ten times lower than that of OX. Accordingly, it is found that the trap density of RNO is lower than that of the silicon nitride film.

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A semiconductor device in accordance with the present invention, for example, is a thin film transistor provided on a transparent substrate. The semiconductor device made of a polysilicon film is provided with (1) a semiconductor layer having a source region and a drain region and (2) a gate electrode provided on a region between the source region and the drain region of the semiconductor layer via a gate insulating film. The semiconductor device is further provided with an organic insulating film made of a condensation polymer having an imide ring such that the organic insulating film covers the gate electrode, the source region, and the drain region. The organic insulating film is formed by applying an organic insulating material such as polyimide, polyamic acid, and other materials, and thereafter by carrying out a calcining process, thereby reducing a trap density of the polysilicon film constituting the semiconductor layer without lowering the productivity due to low throughput, and realizing a semiconductor device which can be suitably adopted as a thin film transistor constituting a matrix circuit section of an active-matrix type liquid crystal display device.

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These phase-resolved SPV measurements are consistent with well known recombination processes in bulk silicon and Si/SiO₂ interface. In the non-hydrogenated areas the trap density is relatively high, and the trapping effect on minority carrier lifetime is substantial.

The recombination efficiency of these traps is influenced by minority carrier occupation, and therefore depends upon minority carrier generation rate. At high excitation levels, the traps are occupied by minority carriers and the trapping efficiency is reduced. At lower excitation levels, trap occupation is reduced, and lifetime is increased due to strong retrapping effect. This dynamic trapping process results in a change in the ability of the modulated SPV signal to follow the excitation pulses. In the hydrogenated areas, the effective trap density is reduced by the hydrogen passivation, suppressing the SPV phase/excitation flux relationship.